SECRET

60-6633 61

#3 of 6

Progress Report

Period of 10-15-61 to 11-15-61

Contract No. AF33(600)40280

General

Major activities for the monthly reporting period:

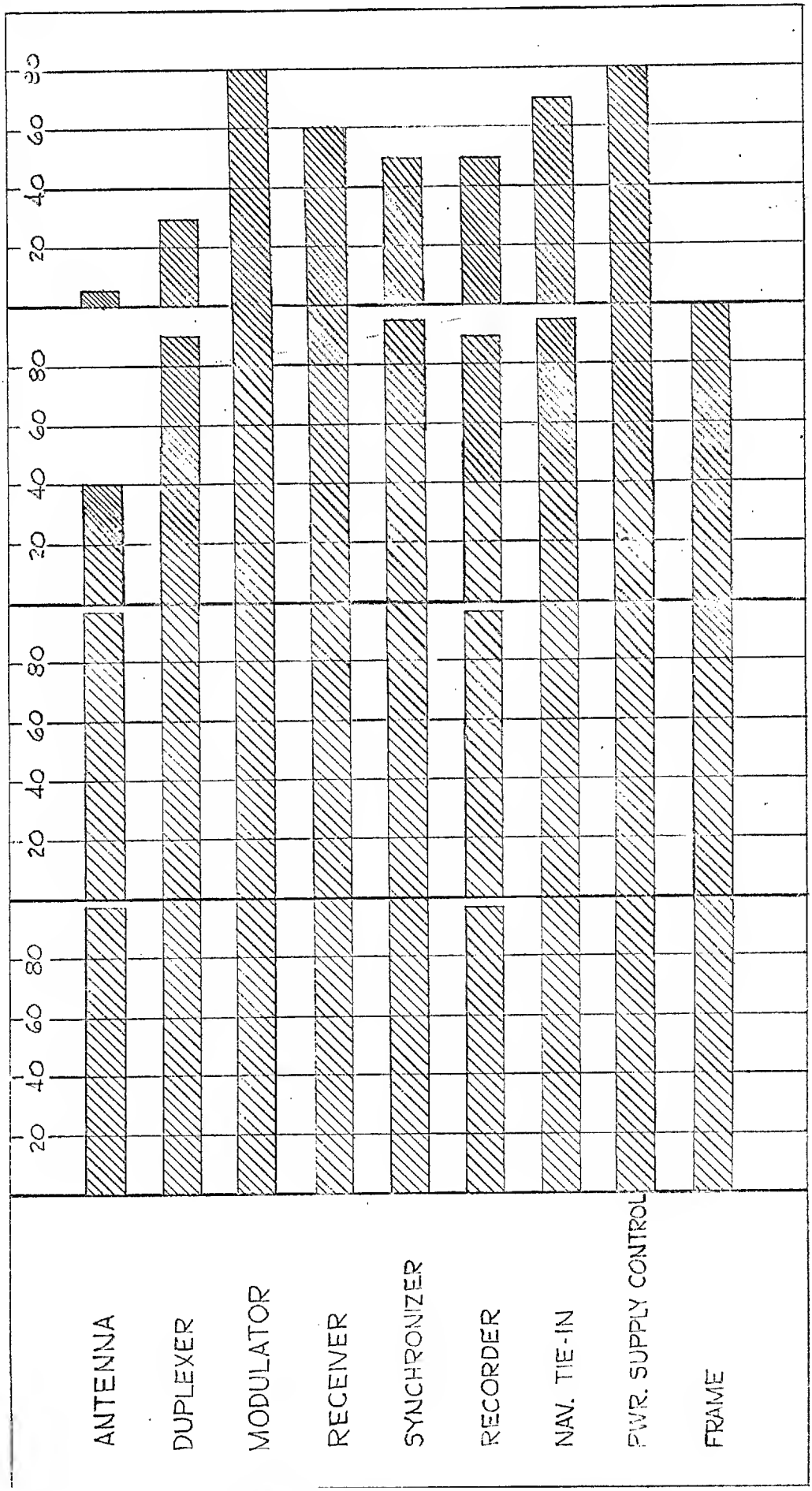
1. Completing assembly of chassis for sets 1, 2 and 3.
2. Composite testing of radar set #1.
3. Modification and cabling of F-101 aircraft.

The chart (page 2) shows in graphical form the status of the first radar system.

In line with the AN/APQ-93 radar schedule furnished last month it is planned to have the #1 radar set ready for delivery sign-off on December 28, with the exception of the antenna. The #1 antenna, being built to the modification required for flight test in the F-101, is scheduled for delivery prior to the first flight on February 1.

PROJECT STATUS

% COMPLETION OF 1ST RADAR FOR PERIOD ENDING 15 NOV. 1961



Flight Test

General

The F-101B aircraft arrived on November 7, 1961 and pilot qualification was completed on November 9, 1961. Four qualification flights were made. On these flights, a quick look at autopilot performance revealed a roll instability of ± 5 degrees at a 2.5 second period in all modes of operation. Because of this, immediate steps were taken to obtain the services of a Minneapolis-Honeywell Tech.-Rep. by November 16, 1961. So that no delays would be encountered in the preliminary aircraft stability flight tests to be conducted during the week of November 20, 1961.

Aircraft inventory was completed on November 14, 1961. The aircraft was then released to Engineering for installation of instrumentation components for the stability flight tests.

Training

Pilot, radar observer, maintenance, and inspection crew training and transition has been completed.

Liaison

A purchase order was placed with McDonnell Aircraft Corp. of St. Louis, Mo. for consulting engineering services. During the previous reporting period, intentions were to employ automatic yaw and drift stabilization of the APQ-93 antenna pod. This was not feasible because of aircraft pod, structural and stability limitations. Planning and installation designs currently include a pitch stabilized antenna pod.

Auxiliary and Ground Support Equipment

Approximately 75% of the aircraft GSE has been received. The remainder is being closely followed and delivery is expected shortly.

A purchase order has been issued to General Precision Laboratories (GPL) for modification of two APN-102 Doppler Navigation Systems. One system has been shipped to GPL and will be returned by December 11, 1961.

Aircraft Modification

a. Fabrication of bracketry to mount instrumentation for the preliminary stability flights has been completed. Aircraft cockpit wiring and remote control installation is complete.

b. Final primary missile door equipment layout was approved on November 7, 1961. Approximately 75% of the detail drawings for door modification are complete and have been released. Modifications to the spare door have begun.

c. The APQ-93 radome design has been completed and a purchase order released. Expected delivery date is December 22, 1961.

d. The APN-102 radome design has been completed and is out for bids. Manufacture is expected to commence on November 21, 1961 with delivery completed by January 14, 1962.

e. The APQ-93 antenna pod design has been completed and is now being detailed. Hydroformed items have been released for manufacture. The shell of the pod (which must be rolled) has been released for bid. Nose and tail cone designs will be released on November 16, 1961.

f. Preliminary layouts of the aircraft nose and cockpit installations have been completed. Details will begin when the preliminary stability flight tests are completed.

g. Aircraft-Systems wiring diagrams are 80% complete. Wiring bills are 40% complete. Two wiremen began cable fabrication on November 13, 1961.

h. The pitch stabilization servomechanism configuration has been established. Existing electronics is being re-packaged for this program. The aircraft control vertical gyro will be used as a reference input.

Instrumentation

Signals to be instrumented and signal conditioning requirements have been established. Fabrication of the units has begun.

System

1. Doppler Tracker

Circuit design of the doppler tracker is proceeding. The proposed system will use a single sideband technique to eliminate the foldover noise. The signal will then be heterodyned to video and passed through a narrow band filter to select a single spectral line for maximum signal-to-noise improvement. The signal will then pass through a discriminator and low pass filter to generate the corrective signal for the voltage controlled reference frequency generator.

2. Conventional Optics Recorder

A preliminary design for a system substituting lenses and mirrors for the fiber optics was presented and approved. Calculations and experiments show that a film on the order of EK#5374 TV recording film will be required to use available light levels. The heart of the proposed system is a pair of Wollensak 6-3/8 f/2 lenses, which are capable of resolution in excess of 100 lines/mm as measured in the aerial image. Lenses have been ordered, and will be further investigated.

Antenna

Array Design - Radome Laminate Design

The most promising technique for sealing slotted array sticks has been found to be one using DuPont ML fabric with 3M silicone adhesive EC1663 (without iron oxide and carbon black) held in place by special clamps.

Pressure-temperature tests of array sticks sealed in this manner have run an average of 250 hours at 550°F before failure occurred. Although longer life is definitely desirable, this technique is the best sealing method presently available. Additional investigation of high temperature sealing techniques applicable to array sticks will be continued.

Fabrication - Flight Test Antenna

Beams

Of the three stainless steel honeycomb beams received, two were returned to the supplier for corrections; the third beam was retained pending return of the other two. The supplier has indicated that beam number 1 will be shipped on 11-18-61.

The solid magnesium beam for the flight test antenna has been completed.

Manifolds

The first electroformed manifold was received on 10-23-61. Initial electrical test results gave evidence of incomplete mandrel removal in a number of mandrel elbows. This was verified by X-rays and the manifold was reworked by the supplier to remove the traces of mandrel. It was subsequently retested electrically and found to be acceptable. As a result of the experience obtained from this manifold, the supplier has been requested to perform X-ray inspection on all completed manifolds.

Supplier has agreed to ship a total of 6 manifolds (a sufficient quantity for the flight test antenna) by 12-8-61, 8 additional manifolds by 1-1-62, and 8 additional manifolds by 2-1-62.

Array Sticks

Supplier of electroformed array sticks has encountered difficulty in obtaining a satisfactory bond between "grown-in" nickel mounting buttons and the array stick proper. A solution to this problem was obtained by using copper plated buttons with a small undercut and allowing two of the buttons to protrude slightly rather than be cut off flush with the stick surface.

Supplier has agreed to ship a total of 96 sticks (complement for flight test antenna) by 12-1-61 and quantities compatible with manifold deliveries from that date. A total of 19 sticks has been received as of 11-17-61.

Duplexer

Three production units of resonant rings were received from Airtron on November 14, 1961. The first assembly has been completed and is now ready for testing. Waveguide switches are not yet available. Tests on prototype EGG switches show that dry nitrogen fill will need O_2 or water vapor, both for hold-off and clean up. It is expected that EGG will supply a tube within two weeks.

Duplexer Driver

Unit #1 has been unit tested.

Power Monitor

Three units are complete and are now in unit test.

Switch Tubes

Evaluation of high pressure nanosecond switching was continued during this period. Various triggering techniques were fixed with the aim of obtaining fast breakdown, low insertion loss, and low arc loss simultaneously. A satisfactory method for obtaining all of these parameters has not as yet been found. The need for a small gap to obtain the fast breakdown time seems to be at odds for obtaining low insertion loss. A low insertion loss and a narrow gap also require very high pressure within the tube to prevent breakdown.

Some trouble has been experienced in measuring breakdown time due to an excessive amount of jitter in test pulsing units and to a good deal of noise being picked up by the scope. Recently a picture was taken of the breakdown time which seems to show that breakdown is faster than suspected and is about 5 nanoseconds.

A dual tube has been built and tested for delivery to the project section. The tube has a shorted end rather than an output window. It has been tested to 40 kw of incident power to each window.

Modulator

Procurement of special cores has delayed completion of the redesigned pulse transformer. It is expected that the first transformer will be received about November 22, 1961. A transformer of the original design was used at reduced voltage to complete testing of the first modulator.

Difficulties were encountered with the latching relays used in the overload circuit. Some of these relays would hang-up in mid-position and others would not reset through their own contacts. Redesign of the circuit to eliminate resetting through the relays own contacts and to aid in achieving a more positive action on overload cleared up this difficulty.

Receiver

T&T

The first two T&T assemblies are complete. Number one is installed on the test frame and is in composite test. The third unit will be completed upon receipt of T&T from the manufacturer. G.E. has been contacted with respect to getting a lower noise figure for tubes now on order. A purchase order has been issued for a fourth tube to be used as a spare.

I.F. Amplifier

The first unit has been tested and is now in composite test. The second is in unit test and the third is complete and in inspection.

Video Amplifier

The first unit has been through unit test and is now in composite test. The second is in unit test and the third is in inspection.

Synchronizer

Frequency Generator

The frequency generator has been "re-breadboarded" with highly satisfactory results. Necessary rework of all original units is now in progress.

A voltage-controlled crystal oscillator has been substituted for the original L-C oscillator. All lock-up difficulties have thereby been removed.

Reworking the I.F. unit has reduced inherent intermodulation to a value which will produce less than 200 cps deviation. If necessary, attempts will be made later to further reduce this deviation by the use of band-pass filters. Fixed and variable units track within $\pm$ 4 cps.

The fourth Bulova oscillator-discriminator unit is expected daily. Provided this unit meets specifications, the entire frequency generator unit will be ready for composite testing.

Synchronizer Generator

The first two units are complete and have been checked out in unit test.

The third unit has been reworked to change logic to produce twice normal PRF to the recorder for flight testing.

STALO And Buffer Amplifier

The first of these units have been put through unit test as far as output power and frequency stability were concerned. Frequency deviation (maximum) over a modulation frequency spectrum between 20 cps and 5 kc was 27 cps. Average drift per a 2-second period was 160 cps, this figure was the average taken over a measuring time of 10 minutes. Drift data was obtained by feeding a second I.F. signal from the LFE stability tester to a counter which would indicate the count for one second.

Some changes were made to increase the loop gain over the low disturbance frequency region and to alter two corner frequencies in the loop response.

The first microwave oscillator and associated components has been released for the system composite test.

Power supplies for the second and third stalo units have been checked out.

Wiring of the phase detectors is complete except for the installation of one diode which is now available.

Three more VA-101 klystrons (Varian) have been received and checked out.

Four cross guide couplers from Microwave Associates were rejected because of reversed flanges and coupling direction. New couplers incorporating an additional auxiliary arm with a coax connector for test purposes are scheduled for shipment on November 20, 1961. These will replace the present couplers.

Recorder

General

All components for the recorder have been received and assembled with the exception of an acceptable fiber optics array. Electronic and mechanical testing have continued. Release for fabrication of units 2 and 3 was completed.

Mechanical

The assembly of the capstan drive roller and drive pulleys was improved to obtain approximately 40 microinch concentricity for smooth film motion.

All subassemblies were completed and assembled into the final assembly. This assembly used an optically rejected fiber array which did not affect the film drive.

Test Rack

The test rack is completed; all power supplies are installed and operating. All read outs are operating except data flash.

Pulse Inputs

Three (3) Rutherford 873 generators are used with two external flip-flops to generate the required 16, 8 and 4 kc test pulses. These generators are physically located in the test rack.

Electronic Package

Debugging the package continues. Film motion and CRT light circuits are now operating properly. However, the data flasher generates a severe transient which upsets the 4 kc blanking circuit. Also, this 4 kc blanking circuit is being triggered at 8 kc by some stray 16 kc pulses. A high voltage leakage problem which burned out several flip-flop transistors has been eliminated. It is thought at this time that a defective CRT caused the trouble.

High Voltage Package

Some difficulty was encountered with the high voltage package supplied by a vendor. This vendor is taking steps to prevent the difficulty in the future.

Inverter

The fixed frequency inverter is producing a satisfactory output. A 2600 mfd capacitor has been added across the 28V input terminals to prevent a transient burn-out during normal operation turn-on.

CRT Light Delayed Indicator Circuit

A delayed indicator circuit for a CRT light malfunction has been devised and was described in a recent technical note. This circuit allows a loss of CRT beam light to go unnoticed for any duration less than 5 seconds. For any loss greater than 5 seconds the CRT light malfunction read-out lamp will blink on and off with a frequency of about 1 flash per second until the malfunction has been cleared.

Fiber Optics

A fiber optic unfolding array was delivered during the report period. After potting and polishing it was determined that one side of the array was unusable, however, the other side had sufficient area to be usable in limited tests. A technique was developed to insure close mating of the array to the cathode ray tube face, by measuring deviation from flatness of the CRT faceplate with an optical flat. The mating part on the unfolding array was then ground to the same sphericity.

The array was mounted to the CRT and the CRT subassembly was mounted into the recorder. Approximately 25 feet of SO-243 was exposed and developed. This brought into focus a new problem of serious import. The CRT beam was unmodulated and should have resulted in producing an exposure of uniform density across the width of the film. However, the exposure on the developed film consisted of density streaks along the length of the film approximately 700 microns wide with relatively clear gaps of 60 microns, caused by misalignment of the multi fiber bundles.

A visit to Mosaic Fabricators, with samples of the film, resulted in no assurance of improvement. However, Mosaic Fabricators will try a different technique of assembling the multi fibers to attempt to alleviate the problem.

Other manufacturers of fiber optics are being contacted to see if there is any possibility of obtaining an unfolding array of sufficient quality.

Navigation Tie-In

The first navigation tie-in unit is now being unit tested. Individual checkouts were made on the drift, pitch and ground speed units.

The first accelerometer amplifier has been checked out although its gain was marginal.

One of four accelerometers received from Donner Scientific fails to respond with changes in acceleration. The other three appear to be satisfactory in response to maximum and zero accelerations. They will now be checked for linearity and hysteresis.

Power Supply and Control

The first units (one power supply and one control panel) have been through unit test and are now in composite test.

Wiring of the second units has been completed and they are ready for unit testing.

The third units are 85% complete.

Frame (Electrical)

Model Shop wiring of the first unit has been completed and this unit is now in composite test.

Frame (Mechanical)

Frame #2 is 90% complete and will be completed on schedule for assembly of system #2.

The piece parts for frame #3 are complete and assembly will start after completion of unit #2.

Development of the first system interconnecting cables has been completed and these cables are now in composite test.

The second system cables are approximately 85% complete.

Truss

The status of this item remains as previously reported.

Stress Analysis

The status of this item remains as previously reported.

Unit Test Cables

Test cables for the first system are complete. Patch cables (two sets) are 90% complete.

System Handling Equipment

The first system test cart has been received and is now in composite test.

Composite Test

Preliminary checkouts indicated satisfactory operation of the following functions:

a. Distribution of 28V DC and 400 cps power for the various modes of operation.

b. Fixed frequency pulse to the receiver.

c. Receiver buffer amplifier output.

A modification is being worked to eliminate failure of the Stalo to lock-up when the unit is cold.

Test Equipment

Composite Test Equipment

The special test equipment for the composite test program was completed and delivered to the project group on November 2, 1961.

Some of the standard test equipment was available from the present laboratory stock. The remainder has been ordered.

Design Evaluation Test Equipment

Clutter Generator and Range Resolution Test Pattern Generator

A noise generator for use in the clutter generator has been constructed and will be ready for test by Friday, November 17.

Some of the long lead components have been ordered. Design and fabrication of this portion of the equipment is approximately 15% complete.

Transponder

All items necessary for the fabrication of the transponder have been ordered. The mechanical layout will be changed to allow a better packaging arrangement. A 30 db fixed attenuator will be deleted from this package by interchanging the monitoring and signal outputs of a 30 db coupler. The 120 MC amplifiers for driving the crystal modulators are being fabricated in the final package.

Azimuth Resolution Test Pattern Generator

The first two stages of the divider which reduces 30 MC to 940 KC have been breadboarded and are working satisfactorily. It was anticipated that the first two steps of the ÷ 128 would present the most difficult problems. The frequency at which these dividers must operate necessitates more elaborate and sophisticated circuitry than will be used in the lower frequency dividers. These dividers are functioning properly at frequencies up to 37 MC.

The multiplication circuits to obtain 120 MC from 30 MC have been breadboarded and are working satisfactorily.

The circuitry for obtaining the pulse position modulation has been breadboarded and operates over a broader frequency range than was indicated by previous information.

Several simplifications in the circuitry of the pattern generator have been made.

Azimuth Resolution Optics Assembly

A method of performing the correlation of the azimuth information has been conceived. The necessary optical components have been placed on order. Breadboarding of the optics will be accomplished as soon as these components are received.

A partial fresnal diffraction pattern was calculated and laid out. It is now being photographically reduced for use in lab experiments and for use with the breadboard.

Electronic Evaluation Circuitry

The power supply for the photomultiplier tube and the power supply for the light source have been breadboarded.

The design and breadboarding of the film evaluator electronics is approximately fifteen percent complete.